Designing with People with Disabilities: Adapting Best Practices of DIY and Organizational Approaches

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ABSTRACT

Individualization of design is often necessary particularly when designing with people with disabilities. Maker communities, with their flexible Do-It-Yourself (DIY) practices, offer potential to support individualized and cost-effective product design. However, efforts to adapt DIY practices in designing with people with disabilities tend to face difficulties with regard to continuous commitment, infrastructure provision and proper guidance. We carried out interviews with diverse stakeholders in the disability services sector and carried out observations of local makerspaces to understand their current practices and potential for future collaborations. We found that makerspace participants face difficulties in terms of infrastructure provision and proper guidance whereas Disability Service Organizations face difficulties in continuous expertise. We suggest that artful infrastructuring to blend the best of both approaches offers potential to create a sustainable community that can design individualized technologies to support people with disabilities.

Author Keywords

Disability services, Individualized design, Maker Communities, DIY Design

ACM Classification Keywords

H.5.2 User Interfaces, H.1.m Miscellaneous

INTRODUCTION

With the advances in technology, production facilities and skilled workforce, there is a growth in production of technological applications. During pre-industrial times people used to develop things they require on their own, making the artefacts catered towards specific needs (Sennett, 2008). This ideology has been disturbed with the dominant *'one size fits all approach'* that fuelled through the industrial revolution. Technological applications both in physical and virtual forms are often produced for a generic population (Hook *et al.*, 2014). The division of labor has ensured that the designers design *for* people rather than design *with* people, that created a difference in requirements and technologies. The HCI community is interested in importance and new ways of incorporating individualized practices in the design of everyday technologies.

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The ability to 'bend' an application towards specific needs is particularly important for people with disabilities (Hsieh *et al.*, 2014; Hook *et al.*, 2014; Johnson *et al.*, 2013). Apart from the usual difference in preferences, people with the same *category* of disability may have varying requirements. While high end technological applications ease access to information and people, they pose difficulties in terms of individualization (Dawe, 2014; De Couvreur & Goossens, 2011). Customizations for such technologies demand some expertise or a monetary payment from the end user (Hook *et al.*, 2014).

Disability Service Organizations (DSOs) have experience in providing long-term support to people with disabilities through their paid and volunteer networks. Projects initiated by the DSOs follow more traditional design methodologies and incorporate disability services experts. While DSOs initiate inspiring designs, adhering to specific methodologies and time plans can limit the room for creativity. DSOs often seek expertise of volunteers to design technologies and one of the DSOs that works closely with our University recruits university students as volunteers. Most of the students involve in these projects as a partial requirement of their degree. While this results in innovative projects, it also poses difficulties in continuous development, as leaving students possess crucial working knowledge of projects.

The notion of maker communities is becoming popular as they follow uniquely flexible practices in collaborative environments that encourage creative designs (Lindtner *et al.*, 2014). The artefacts they create are often individualized as the end users are the ones who build them, making the gap between the designer and user minimal. The knowledge sharing in collaborative environments also aids bridging this gap. The main roots of their efforts are intrinsic motivations to design things and are not often restricted by technology or strict project plans (Jackson & Kang, 2014; Moilanen, 2012). They use tools such as kit technologies and 3D printing that can be learnt easily and day-to-day objects to create artefacts (Hook *et al.*, 2014; Hurst & Kane, 2013).

If flexible DIY design practices can be adopted in organizational efforts, there is a potential to improve the quality of individualization in design while keeping the costs low (Hurst & Kane, 2013; De Couvreur & Goossens, 2011; Hurst & Tobias, 2011). Disability service expertise and infrastructural resources of DSOs may aid people who develop technologies with people with disabilities to sustain their projects (Hook *et al.*, 2014). To identify and adapt such practices, it is necessary to understand different motivations, success factors and difficulties of maker communities and DSOs. Such studies can pave the way for collaborations amongst makers and DSOs that can further enhance design practices. This paper explores ways to adapt best practices of DIY and DSO approaches in co-designing technologies with people with disabilities.

LITERATURE REVIEW

It is commonly believed that that a technology catered towards a specific category of disability can serve every person in that category (Kintsch & Depaula, 2002). Some researchers argue that this approach is an over-simplification as each person may have contrasting requirements even though they may fall into the same category (Hook *et al*., 2014; De Couvreur & Goossens, 2011; Scherer, 2002). Off-the-shelf commercial applications are usually made for a generic population and often fail to meet complex individual needs (De Couvreur & Goossens, 2011; Scherer, 2002). If customizations are required (which is often the case), user needs to be an expert in tweaking the technology or needs to pay extra money get it done by experts (Hook *et al*., 2014; Kintsch & Depaula, 2002).

Maker communities are of interest as they foster DIY design practices that result in individualized technologies at lower costs. A maker community is a group of people who get together regularly and work on common constructive interests ranging from making toys to developing high end robots (Lindtner *et al*., 2014). They use existing artefacts and site-specific tools such as high-level electronic kits, 3D printers and laser cutters to create artefacts (Hartmann *et al*., 2008). The availability of online support and the collaborative nature of makerspaces make it easy to learn such tools, lowering the entry barrier in design for non-experts (Lindtner *et al*., 2014). The use of discarded/day-to-day objects as design materials helps to lower the cost of design while maintenance cost are kept at a minimum due to the user's role as the maker (Jackson & Kang, 2014). Although uncommon at present, makerspaces are moving from a sole focus on technical interests such as electronics, computer networking and robotics, towards more social aspects such as fostering collaboration, exhibitions and workshops (Lindtner *et al*., 2014; Moilanen, 2012).

There are efforts to empower people with disabilities using DIY practices, though large scale collaborative work is seldom seen (Hook et al., 2014). In an inspirational series of workshops, university students collaborated with people with disabilities to envision and develop various day-today gadgets using DIY tools (Mcallister, 2012). This project yielded positive results in terms of engagement during the design, as much as for the resulting designs themselves. The group formed for this particular project was dissolved afterwards due to the other commitments of the students. The Robohand (2013) is a project to make workable prosthetic mechanical hands. The project was borne of a disabled person's need and collaborations with other parties such as maker communities and organizations led him to produce prosthetic hands for more than 200 people.

Hook et al., 2014; Hurst & Kane 2013; and Hurst & Tobias 2011 have discussed the benefits of DIY approaches in designing with people with disabilities. They argued that such an approach has the potential to develop individualized technologies whilst keeping down design and maintenance costs. While their studies focused on using DIY technologies with pioneering groups of people with disabilities, they have not considered collaborative efforts between DSOs and maker communities. Bannon and Ehn (2012) discussed the importance of building hybrid models of different design practices. They argued that blending of organizational practices with new 'open' forms of innovative approaches holds the key for design appropriation. We suggest that such an infrastructure is required particularly for the design of technologies with people with disabilities to sustain longer with enhanced benefits.

This project explores the potential of developing hybrid approaches that draw upon successful practices of DIY communities and DSOs. DSOs have experience in providing long-term support to people with disabilities through their paid and volunteer networks, although they may lack experience in DIY technologies. DIY communities on the other hand are creative spaces supporting DIY, but in their ability to reliably apply their efforts to supporting people with disabilities to create individualized technologies is unknown.

METHODS

A series of in-depth semi-structured interviews was carried out with six participants in the disability services field. Interview participants included two innovators with disabilities (P1 & P2), an executive member of a DSO (P3), a designer who develops software and hardware applications with people with disabilities (P4) and two occupational therapists (P5 & P6). P1 was also an executive member of a DSO in the USA. P2 is a technician affiliated with a technology research institute in Australia. P3, P4 and P5 were affiliated with a DSO in Australia. P6 was an occupational therapist affiliated with a DSO for people in remote areas in Australia. Interviews lasted approximately one hour and discussions were based on several key areas such as their personal and organizational design practices, current technologies and the importance of design individualization.

In addition to the interviews, some preliminary discussions have been carried out with a DSO (D1) that works closely with our University to initiate co-design projects amongst students, academic staff and people with (especially with intellectual) disabilities. This DSO supports people with disabilities in Australia to have opportunities and choices of an ordinary life. Over two months we attended some of their meeting groups and have held discussions with executive members and academic staff members. Two of the authors worked actively in some projects initiated by D1. These projects are scoped to last one semester and students earn academic credit for completing tasks. Two local makerspaces have been observed over three months to understand their practices. Simple observations of makerspaces and informal discussions with members were conducted. One of the makerspaces develops creative technological devices mostly as hobbies of the members (M1) while the other makerspace develops gadgets that are sometimes catered for external users (M2). In both makerspaces, paid members can attend the physical workspaces anytime and work on their projects while the public can visit on specific days to have a look and have discussions. Additionally, we attended some regular meet-ups and volunteered in a *maker faire*. A Maker Faire is an exhibition of design artefacts created in a makerspace (Jackson & Kang, 2014).

FINDINGS

Three main themes emerged from the investigations: motivations to develop technologies, design practices and the need for collaborations.

Motivations

All the interview participants highlighted the importance of catering for specific needs particularly for people with disabilities. As an example, P5 stated that the layout of buttons of a video game controller device is crucial since people have unique physical orientations. *"One technology you develop will not be suitable to another even if they have the same type of a disability"*. The Cost of high end technologies is another barrier pointed out by the participants. P4 and P6 mentioned that one of their clients opted to design a DIY keyboard for his son who has upper limb movement difficulties as commercial products are very expensive. One of the key motivations for the students to engage in the projects initiated by D1 is the reward of academic credits. However, further in-depth discussions are required to explore other motivations they may possess towards such projects.

While cost and individualization seem to be the key motivations according to the interview participants, people involved in makerspaces seemed to have different perspectives. Individualization in fact is an inherent result of user being the maker and cost was much less an issue than the experience and satisfaction of making an artefact. We noticed that some of the artefacts can be purchased even off-the-shelf without much cost difference. At the maker faire we witnessed a strong sense of pride in their inventions. Although some microcontrollers were there for sale we could not see any artefact with a price tag. Preliminary discussions with some of the makers suggested that they enjoy making different artifacts in the absence of a wish for capital gain. This was evident with some of the artefacts (a single string guitar, a toy spider) that were purely made for fun than for functional requirements. We found that the intrinsic motivations to design artefacts mattered much more than the cost as a maker noted *"Developing something useful for you on your own can mean the world to you!"*

Design Practices

Makers like to experiment with objects, sometimes without thinking much about the aesthetics or functionalities. *"We build first, plan later"*. They accept the possibility of making errors both as a challenge and an opportunity to learn new things. Their learning methods are focused around friendly chats within the makerspaces and online resources. We have noticed that most of the members are happy to share their knowledge or even physical resources (gadgets, sensors, electronic kits, etc.). Their attitude of learning through doing facilitates a flexible design approach where changes can be made at almost any time in the design cycle. However, it was difficult to see many proper documented accounts of their designs apart from some online blogs and notes. The design practices that D1 follow are well documented such as *Agile Software Development Methodology*. With the timelines of the students and stakeholders they don't have much option, but to adhere to such methodologies, strict timelines and documenting practices.

Need for Collaborations

P2 collaborated with a motorcycle mechanic to build a scooter that can be operated from his wheelchair that is placed in the sidecar. This invention has given him an enormous increase in independence. He stated that he has used his knowledge in mathematics and computer science with the help of his able-bodied friends in the development. *"I did not get any support from any organization. This was an effort entirely by me and my friends"*. He publicised and shared his design though his blog in order to encourage other people with disabilities to develop their own personal transport. However, he did not see any evidence of this invention reaching a wider community. His comments suggested a potential of reaching a wider audience with the support from organizational resources and continuous expertise. He also mentioned the importance of providing more control over the design for end users in order to elevate their 'sense of security'. He suggested a promising approach would be to use DIY technologies, such as electronic kits that are usable by a wide range of people. P4, P5 and P6 also appreciated the potential of DIY electronic kits to design such technologies as they are easy to learn and inexpensive. Such practices can allow people with disabilities and their support groups to design technologies that can not only reduce frustrations, but also can provide rewarding experiences.

A discussion with one of the founding members of M1 revealed that two of their members have physical disabilities and are attempting to develop technologies for themselves. But, he noted that their progress with the design is slow as there is no advice and support from disability services experts. Collaborations with DSOs might be a promising way to provide this support to sustain longer.

Difficulties that DSOs face are mainly focused around continuous volunteer involvement. After the completion of the projects, students move on, although there are cases where some students stay longer to provide support. Ensuring continuity is one of the concerns highlighted by executive and academic staff members involved with D1. DSO service provision focuses mainly on technology adaptation and use rather than technology design and development for individual needs. The prospect of engaging in more DIY design work to support individuals is appealing but untested. Some executive and university staff members involved with D1 suggested designing collaboratively with external parties such as maker communities may has the potential to overcome these difficulties.

DISCUSSION AND CONCLUSION

Investigations of both DSOs and makerspaces reinforced the claims in literature of benefits in adapting DIY practices in design efforts with people with disabilities. The flexible DIY practices and the supportive environments of maker communities may facilitate more individualized and creative design ideas while lowering the cost of development. Increased participation of end users in the design process can reduce frustrations in use of technologies. Makerspaces consist of people who possess intrinsic motivations to create new things. Whether such motivations of makerspace members will extend to working on projects with people with disabilities is an open question that requires further investigation. We suggest that while adapting DIY is beneficial, integrating infrastructural practices of DSOs may also be necessary. Managerial and infrastructural resources of DSOs may aid people who are interested in designing with people with disabilities to receive proper guidance to improve and sustain their work (Hook *et al.*, 2014).

While it is difficult to see organized collaborative efforts in practice, we have sensed a willingness to do so amongst the makerspaces and DSOs. We suggest that an artful blend of practices of makerspaces and DSOs might benefit stakeholders in number of ways. DSOs can benefit from flexible design practices and DIY expertise from makerspaces whereas makerspaces can benefit from disability service expertise and infrastructural resources from DSOs. Ultimately people with disabilities can benefit from the provision of individualized technologies at low costs and ongoing support for maintenance and development. Such an approach has the potential to improve the quality of products and sustainability of the projects. Essentially, what we are proposing is artful infrastructuring (Star & Bowker, 2006) to strengthen the efforts of designing technologies with people with disabilities. Such infrastructuring encompasses drawing together of resources, practices and values from different streams to nurture co-design practices (Bannon & Ehn, 2012). This study will explore key infrastructural elements of DIY and DOS practices through collaborative approaches. Initiating regular inter-party meeting groups, workshops from each party and mini-maker faires in collaboration with local makerspaces and DSOs can be promising ways forward. Further investigations of motivations and difficulties for each stakeholder may help to understand effective collaborative practices. While collaborations may lead to projects that can benefit people with disabilities, collaborative design experiences can potentially generate guidelines for projects where individualized technologies are required at lower costs to empower people with disabilities.

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